



HAL
open science

Choosing a Questionnaire Measuring Connectedness to Nature for Human-Computer Interaction User Studies

Elodie Bouzekri, Guillaume Rivière

► To cite this version:

Elodie Bouzekri, Guillaume Rivière. Choosing a Questionnaire Measuring Connectedness to Nature for Human-Computer Interaction User Studies. Actes de la 33e conférence internationale francophone sur l'Interaction Humain-Machine (IHM'22), AFIHM, Apr 2022, Namur, Belgium. <10.1145/3500866.3516380>. <hal-03847552>

HAL Id: hal-03847552

<https://hal.science/hal-03847552v1>

Submitted on 17 Nov 2022

HAL is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire HAL, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



HAL Authorization

Choosing a Questionnaire Measuring Connectedness to Nature for Human–Computer Interaction User Studies

Choisir un questionnaire mesurant le rapport à la nature pour
des études utilisateur en Interaction Humain-Machine

Élodie Bouzekri
elodie.bouzekri@estia.fr

Univ. Bordeaux, ESTIA INSTITUTE OF TECHNOLOGY
Bidart, France

Guillaume Rivière
g.riviere@estia.fr

Univ. Bordeaux, ESTIA INSTITUTE OF TECHNOLOGY
Bidart, France

ABSTRACT

Evaluation of human–computer interfaces that aim at shaping users’ pro-environmental attitudes and behaviors should consider measuring participants’ affinity with nature: analyses of user studies in this context have to discriminate a possible effect on the results. This paper proposes to guide the choice between 21 questionnaires available in the literature measuring the Connectedness to Nature (CtN) construct. We thus share a review and an analysis that we made to choose one scale questionnaire for our needs of a user study recruiting in public places and a longitudinal user study aiming to evaluate the use and impact of shape-changing interfaces at workplaces to assist pro-environmental behavior. This paper analyzes questionnaires through eight criteria for Sustainable HCI user studies, reports some meta-analyses’ results, illustrates two questionnaire choices, then overviews the limitations of available questionnaires for user studies in HCI.

RÉSUMÉ

L’évaluation d’interfaces humain-machine visant à agir sur les attitudes et les comportements pro-environnementaux de leurs utilisateurs devrait tenir compte du rapport à la nature des participants : l’analyse d’études utilisateur dans ce contexte doit en effet pouvoir discriminer un possible effet sur les résultats obtenus. Cet article propose de guider le choix parmi 21 questionnaires issus de la littérature mesurant le rapport à la nature (via des échelles du construit *Connectedness to Nature*, CtN). Nous reprenons une revue et une analyse que nous avons conduites pour en choisir un répondant à nos besoins pour une étude recrutant sur l’espace public et pour étude utilisateur longitudinale visant à évaluer l’utilisation et l’impact d’interfaces à changement de forme sur des lieux de travail afin d’accompagner un comportement environnemental. Cet article analyse les questionnaires selon huit critères relatifs aux études utilisateurs en IHM pour la soutenabilité, reprend les résultats de méta-analyses et illustre deux choix de questionnaire,

puis revient sur les limitations de l’offre de questionnaires pour des études utilisateur en IHM.

CCS CONCEPTS

• **Human-centered computing** → **User studies**; • **General and reference** → *Evaluation*; • **Social and professional topics** → *Sustainability*; • **Applied computing** → *Psychology*.

KEYWORDS

HCI; Sustainable HCI; Sustainability through Design; User studies; Environmental psychology; Attitudes measurement; Pro-environmental values; Questionnaire; Connectedness to Nature.

MOTS CLÉS

IHM; IHM durable; Soutenabilité par la conception; Études utilisateur; Psychologie environnementale; Mesure des attitudes; Valeurs pro-environnementales; Questionnaire; Rapport à la nature; Connectivité à la nature.

ACM Reference Format:

Élodie Bouzekri and Guillaume Rivière. 2022. Choosing a Questionnaire Measuring Connectedness to Nature for Human–Computer Interaction User Studies: Choisir un questionnaire mesurant le rapport à la nature pour des études utilisateur en Interaction Humain-Machine. In *IHM ’22: Proceedings of the 33rd Conference on l’Interaction Humain-Machine (IHM ’22)*, April 5–8, 2022, Namur, Belgium. ACM, New York, NY, USA, 13 pages. <https://doi.org/10.1145/3500866.3516380>

1 INTRODUCTION

Some environmental consequences of human activities are already unavoidable. For example, the sixth IPCC’s Assessment Report on climate change states in 2021: “*Human-induced climate change is already affecting many weather and climate extremes in every region across the globe. Evidence of observed changes in extremes such as heatwaves, heavy precipitation, droughts, and tropical cyclones, and, in particular, their attribution to human influence, has strengthened since AR5 [The fifth Assessment Report in 2013]*” [48]. However, impactful actions are possible for a better future. User Interfaces that help users limit resource consumption are part of such strategies. Even so, approaches merely aiming to improve technological efficiency (energy consumption or production of technologies) will not be sufficient to achieve sustainability [33]. These approaches must thus be combined with sufficiency strategies [33], which aim at changing users’ behavior. HCI thus has a role to play to help

users control their energy consumption and have beneficial impacts to overcome the current environmental crisis.

Sustainable HCI (SHCI) adds environmental considerations to HCI objectives. Mankoff et al. [45] distinguish two approaches in SHCI. First, Sustainability *in* Design aims to mitigate software and hardware’s material effects on the environment (in line with Green IT approaches) and reduce rapid product obsolescence cycles [4]. Second, Sustainability *through* Design (SHCI-TD) aims to influence decision-making and sustainable lifestyles—this work follows this second approach. Di Salvo et al. [19] identify persuasive technology as a major genre of SHCI-TD. Fogg defines *persuasive technology* as an interactive technology that changes attitudes or behaviors [27]. In order to influence environmental behavior, SHCI-TD systems can provide information to users about their degree of sustainability (like wasting, recycling, or saving resources) or their degree of resources’ consumption (e.g., water [1, 28, 41] and energy [14, 15]). Although a controversy calls into question these work because tackling small individual gestures and considering users as resource managers [8, 21, 80], the community strives to reorient systems on socially-shared practices [38, 39, 59, 65].

We consider two illustrative cases. First, some systems aim to change people’s attitudes by interacting shortly in public places (e.g., StationENR [64]). Second, some systems aim to shape or assist people’s behavior in the long term in semi-public spaces such as workplaces (e.g., CairnFORM [14]). Evaluating and assessing such systems’ impact on what users think and how users behave should consider gauging an environmental index about participants’ affinity toward nature¹. Such an index would indeed be helpful for the needs of user studies results’ interpretation and work replicability and reproducibility, when comparing efficiency between groups and between studies.

Since the 1970’s—when the environmental concern started raising attention—the social and behavioral sciences’ literature developed tools measuring pro-environmental attitude (e.g., New Ecological Paradigm [22]) and behavior (e.g., General Ecological Behavior [34, 35]). Some tools ask respondents about what they *think* (values, beliefs, feelings) [23, 49], what they *do* (behavior) [34, 35], or what they *are* (identity) [10] about nature. These tools aim to measure how much people relate, or not, to nature. Wilson’s biophilia hypothesis [84] outlines the innate human affinity for life and lifelike processes, but numerous drivers disconnect humans from nature [85]. For example, the urban lifestyle contributes to a loss of affective and cognitive relationships with nature [2].

The extent to which each individual relates to nature is thus variable. Based on the assumption that the separation between the vision of the self (or humanity) and nature contributes to the lack of willingness to act to preserve nature, environmental psychologists developed tools to measure this affinity through the concept of Connectedness to Nature² (CtN). These tools

are scales measuring Connectedness to Nature constructs, using questionnaires about knowledge, beliefs (including worldviews), affect, motives, behavior, and identity. Environmental psychologists found that Connectedness to Nature is positively linked with environmental behavior [85]—what makes it a reliable measure for SHCI user studies needs.

This paper shares a review and an analysis that we made to choose a Connectedness to Nature scale for our needs of a longitudinal user study aiming at evaluating the use and impact of shape-changing interfaces to assist behavior change on semi-public spaces (e.g., displaying renewable-energy and behavior-feedback data). These interfaces will assist users at workplaces toward pro-environmental behaviors, as does CairnFORM [13, 14]: the behavioral changes that we study are about specific tasks—not about a global lifestyle change.

Choosing a Connectedness to Nature questionnaire for the needs of Sustainable HCI user studies requires HCI researchers to explore a variety of work: scales and their questionnaires are spread among several papers, are sometimes revised or adapted, and are often cited with different names and acronyms. Hence, the choice of a questionnaire could benefit from some guidance. We ask the following question: how to choose a questionnaire for evaluation needs in Sustainable HCI? This paper proposes eight criteria related to the context of SHCI-TD user studies, uses them to classify and analyze 21 scales and their questionnaires, and then summarizes experimental validations and comparisons between eight of those questionnaires. Then, we illustrate questionnaire choices for two cases. Finally, we expose our analysis of scales’ limitations for SHCI needs and discuss recommendations for the HCI community.

2 RELATED WORK

The performance or success of Sustainable HCI systems designed to affect lifestyles lies in their impact on users’ behavior: the question of measuring “sustainability impact” is thus addressed by the Sustainable HCI community. In 2010, Silberman and Tomlinson [77] distinguish three approaches to evaluate Sustainable HCI projects: (1) the *principles* approach checks that the project matches with some global principles for sustainability defined by experts; (2) the *heuristics* approach measures some indicators (e.g., resulting from user behaviors or device designs); (3) the *indices* approach measures composite environmental indices (e.g., ecological footprint). In 2017, Remy et al. [62] list four ways to assess impact in Sustainability *through* Design: large-scale deployments, long-term studies, participatory design, and goals redefinition with different models. In 2018, Remy et al. [61] propose a metamodel to evaluate research artifacts in HCI to provide guidance for evaluations in Sustainable HCI. Whereas pro-environmental knowledge, beliefs (including worldviews), affect, motives, activities, and identity seem a prerequisite to sustainable behavior and lifestyle [49], measuring these environmental values and identity seems absent from previous work on Sustainability *through* Design evaluation, even though they can affect systems’ performance and results’ interpretation.

¹The word “nature” refers to all the living entities other than human and non-living entities not human-made. “Nature” is a social construct: its definition is highly variable across cultures and reflects interactions and perceptions of other living entities [18].

²The word “connectedness” refers to connection, mutual dependence (being linked), and a sense of belonging or affinity. *Connectedness to Nature* is now established as the leading term of the measure [63]; however, several terms refer to this concept in the literature, such as *Connection to Nature*, *Connection with Nature*, *Connectedness with Nature*, *Nature Relatedness*, *Human–Nature Relationships*, or *Affinity with Nature*. A practitioner’s guide is available to the interested reader [66].

3 CONNECTEDNESS TO NATURE

The Connectedness to Nature concept provides a framework to capture respondents’ relationship toward the environment and nature. This concept from environmental psychology refers to the identification and relationship with nature that is personal for each one. Zylstra et al. refer to Connectedness to Nature as “a stable state of consciousness comprising symbiotic cognitive, affective, and experiential traits that reflect, through consistent attitudes and behaviors, a sustained awareness of the interrelatedness between one’s self and the rest of nature” [85]. Thus, the Connectedness to Nature construct can be considered as the outcome of nature-related dimensions comprising [63, 85]: (1) *cognitive dimensions* (knowledge and beliefs); (2) *affective dimensions* (feelings and emotions); (3) *behavioral dimensions* (actions and experience).

The Connectedness to Nature concept encompasses numerous constructs varying according to their importance to the cognitive, affective, and behavioral dimensions. For example, the *love and care for nature* construct [57] emphasizes affective aspects, and the *disposition to connect with nature* construct [6] emphasizes affective and behavioral dimensions. We illustrate the Connectedness to Nature concept in Figure 1. We merge environmental *motives* with *affects* as the related scale asks respondents what they care about (i.e., environmental problem consequences that concerned them the most) [71]. In addition, we make *identity* a dimension of Connectedness to Nature because several scales emphasize the inclusion of nature in identity [10, 44, 72]. Committed Connectedness to Nature refers to the sustained embodiment of Connectedness to Nature as a behavioral set to serve social and ecological communities through transformative leadership [85]. This behavioral set includes pro-environmental behavior such as experimenting and improvising for self-sufficiency [85].

The level of Connectedness to Nature can be measured using evaluation tools: constructs’ dimensions are measured using scales shaped as questionnaires comprising items, as illustrated in Figure 2. Scales can be composed of sub-scales or divided into categories. For example, EAATE [83] contains three categories: environmental apathy, anthropocentrism, and ecocentrism. Each sub-scale or category has specific items. Items’ measurements provide values that can be computed for each sub-scale or category. The whole questionnaire provides an overall measured value of the construct. We detail these constructs and tools in the following sections.

As literature reviews reported [63, 85], several empirical studies suggest that Connectedness to Nature strongly predicts environmental behavior. Thus, users with a high connection to nature will be more likely to exhibit environmental behavior already or change their behavior to a more environmentally-friendly one. As well, the reverse relationship is possible. For example, Ernest and Theimer [26] show that performing an environmental behavior strengthens children’s Connectedness to Nature.

4 CRITERIA FOR SHCI-TD STUDIES

This section presents eight criteria to select and compare tools measuring Connectedness to Nature. We choose those criteria according to the measurable characteristics of Connectedness to Nature scales and the needs of SHCI-TD user studies.

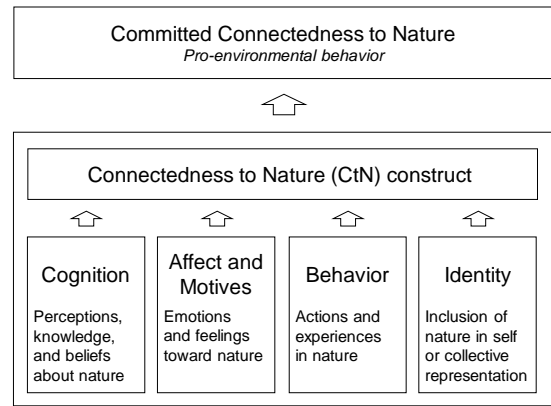


Figure 1: Illustration of the Connectedness to Nature concept and its dimensions based on Restall and Conrad [63], and Zylstra et al.’s [85] descriptions.

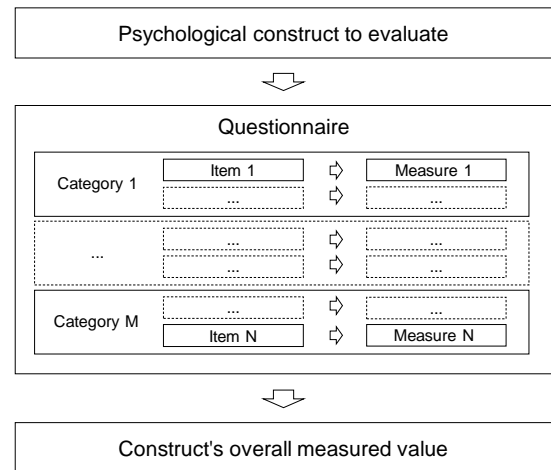


Figure 2: Illustration of scales toolchains.

4.1 Point of View

We discriminate four points of view that are used in questionnaires to place respondents’ thinking when they are reading the items:

- **Aggregate (‘A’):** Items’ scope is humanity viewed by respondents. Example: “*Humans were meant to rule over the rest of nature*” [23]. These items are usually measured using Likert scales (i.e., from “Strongly Disagree” to “Strongly Agree”);
- **Individual (‘I’):** Items’ scope is the respondent’s view of himself. Example: “*When I think of my place on Earth, I consider myself to be a top member of a hierarchy that exists in nature*” [49]. These items are usually measured using Likert scales (i.e., from “Strongly Disagree” to “Strongly Agree”), but can also be measured using frequency scales (i.e., from “Never” to “Always”), identity scales (i.e., from “Not at all true of me” to “Completely true of me”), or Venn Diagrams (i.e., a series of pairs of circles—one representing “Me”, the other one “nature”—that overlap more or less);

- Portrait ('P'): Items' scope is the respondent's view of himself relative to others. Example: "*It is important for her to be in unity with nature*" [5]. These items are measured using portrait scales (i.e., from "Not like me at all" to "Very much like me");
- Concept ('C'): Some concepts are described using only a few words; respondents rate their connectedness with a concept or associate some concepts together. Example: rating "PREVENTING POLLUTION" [79], or associating "ANIMAL" with "NATURE" or "BUILT" [73]. These items are rated using importance scales (from -1: "opposed to my values", to 0: "not important", to 7: "of supreme importance") [79], or measured using association response speed [73].

4.2 Construct Dimensions

Questionnaires vary according to Connectedness to Nature's measurable dimensions. Restal et al. [63] propose classifying questionnaires according to the dimensions addressed by their items: cognitive, affective, and behavioral. We propose to refine this classification into the following: knowledge ('K'), beliefs ('Bl'), affect and motives ('AM'), behavior ('Bh'), and inclusion of nature in identity ('Id'). We consider as *knowledge* all environmental facts part of a scientific consensus (e.g., human-caused global warming [12]).

4.3 Age Groups and Languages

Questionnaires are designed for specific age groups; some are later adapted to other age groups. As SHCI-TD user studies can take place in public areas where all types of public may participate, adequate questionnaire versions must be used. We therefore distinguish three age groups to classify the questionnaires' audience: adults ('A'), teenagers ('T'), and children ('C').

Evaluating SHCI-TD systems across countries by the international research community requires valid questionnaires available in local respondents' languages. We distinguish the original language of questionnaires ('o'), from validated translations ('v'), two-way back-translations ('b'), and one-way direct-translations ('d'). We thus reported questionnaires for six languages: English ('EN'), French ('FR'), Spanish ('SP'), Italian ('IT'), German ('GE'), and Portuguese ('PT')—only questionnaires whose papers provide the translated items were included.

4.4 Consistency and Measurement

When provided by their authors, we reported questionnaires' internal consistency through the Cronbach's alpha coefficient (Tau-equivalent reliability). We also reported the kind of measurement between 'Likert Scale', 'Yes/No Questions', and 'Other'. The latter kind includes other measurements such as importance scales (i.e., from -1: "opposed to my values", to 7: "of supreme importance"), identity scales (i.e., from 1: "Not at all true of me", to 4: "Neither true or untrue", to 7: "Completely true of me"), frequency scales (i.e., from "Never" to "Always"), portrait scales (i.e., from "Not like me at all" to "Very much like me"), Venn Diagrams, or words association time.

Table 1: Corpus composition from literature reviews, showing included papers' occurrence between reviews.

Source	Included				Rejected
	Once	Twice	Thrice	Total	Total
Zylstra et al. (2014) [85]	1	5	6	12	1
Restal and Conrad (2015) [63]	6	6	5	17	1
Salazar et al. (2021) [67]	0	0	6	6	2
Own literature review	3	0	0	3	0

4.5 Questionnaire Administration

Although administration time is a decision criterion when choosing a questionnaire, the average times to take tests were not measured when validating scales and are not provided for any of the scales. Connectedness to Nature's questionnaires were designed to understand a population's psychology at a large scale as the main question, not as a secondary variable at the scale of HCI user studies analyses. User studies' participants usually have to answer a variety of questions: questions about themselves (demography) and their skills (experience), and about the user interfaces or the tasks (usability), for example. Answering those questions takes time during user studies: time of the participants and time of the experimenters, involving energy of both persons. Measuring Connectedness to Nature requires adding more questions, thus increasing completion time and leading to inappropriate administration time. First, longitudinal user studies' participants may have some time planned to answer, but they will have to take some questionnaires several times and get bored with long questionnaires over time. Second, participants of user studies recruited in public places may have a short time to answer.

We examined questionnaire administration through two criteria: questionnaire items count ('#Items') and estimated their reading time ('Time') (not including the instructions provided with some questionnaires)—we consider a reading speed of 200 words/minute.

5 THE CORPUS

We collected scales from three systematic literature reviews on Connectedness to Nature [63, 67, 85] to which we added three scales from our own literature review. Inclusion criteria were self-report scales measuring Connectedness to Nature (as a whole or partially) at least for adults. The composition of the corpus is summarized in Table 1. The resulting 21 scales are listed in Table 2 (acronyms, names, and references). Although some of these scales are considered as "Attitudinal and Values-Based Scales" (EMS and LCN), or as "Paradigm-Based Scales" (NEC and NEP) by Keaulana et al. [37], and some were considered not measuring the Connectedness to Nature's construct by a workshop's participants (EAATE, PRS, EVO, NEP, CWN, and COM) [67], we included all these scales as measures of Connectedness to Nature in our corpus.

The remaining of this section depicts eight of the 21 scales: seven are among the most common [78], most useful to practitioners [67], and most frequently cited [85] scales (see Table 3): NEP, EATN, INS, EID, CNS, NRS, and LCN; one is the only computerized test of the corpus: IAT.

Table 2: Names and references of the 21 scales of the corpus (ordered by the main reference’s publication year).

Scale		References			
# Acronyms	Name	Authors	Year	Main	Other
1. EAATE	Ecocentric and Anthropocentric Attitudes Toward the Environment	Thompson and Barton	1994	[83]	[74, 76]
2. PRS	Perceived Restorativeness Scale	Hartig et al.	1997	[31]	-
3. NEC	New Ecological Consciousness	Ellis et al.	1997	[25]	-
4. EVO/E-SVS	Environmental Value Orientations Scale	Stern et al.	1998	[79]	[17]
5. EATN/EAN	Emotional Affinity Toward Nature	Kals et al.	1999	[36]	[51]
6. NEP	New Ecological Paradigm	Dunlap et al.	2000	[23]	[22, 46, 68, 69]
7. EMS	Environmental Motives Scale	Schultz et al.	2001	[71]	[20, 71]
8. INS	Inclusion of Nature in the Self	Schultz et al.	2002	[72]	[43, 47]
9. EID/EIS	Environmental Identity	Clayton	2003	[10]	[11, 55, 60]
10. IAT	Modified version of the Implicit Associations Test	Schultz et al.	2004	[73]	[7]
11. CNS/CTN (CNI)	Connectedness to Nature Scale	Mayer et al.	2004	[49]	[9, 52, 55, 58]
12. HARN	Human Actions in and Reactions toward Nature	Beckers	2005	[3]	-
13. CWN/CwNS/ECS	Connectivity With Nature	Dutcher et al.	2007	[24]	-
14. AID	Allo-inclusive Identity	Leary et al.	2008	[44]	-
15. COM	Commitment to the environment	Davis et al.	2009	[16]	-
16. NRS/NR	Nature Relatedness Scale	Nisbet et al.	2009	[54]	[20, 53]
17. LCN	Love and Care for Nature	Perkins et al.	2010	[57]	[50]
18. DCN	Disposition to Connect with Nature	Brügger et al.	2011	[6]	-
19. EAATSD	Ecocentric and Anthropocentric Attitudes Toward the Sustainable Development	Kopnina et al.	2013	[40]	-
20. DENS	Dispositional Empathy with Nature Scale	Tam	2013	[82]	[75]
21. E-PVQ	Environmental Portrait Value Questionnaire	Bouman et al.	2018	[5]	[20]

Note. '-' = empty.

Table 3: The seven scales qualified as the most common, most useful, and most frequently cited.

# Scale	Most common [78]	Most useful to practitioners [67]	Most frequently cited [85]
5. EATN/EAN	-	-	×
6. NEP	×	-	-
8. INS	-	×	×
9. EID/EIS	×	×	×
11. CNS/CTN (CNI)	×	×	×
16. NRS/NR	-	×	×
17. LCN	-	×	-

Note. '-' = empty.

5.1 New Ecological Paradigm Scale

The New Ecological Paradigm [23] is a revised version of the New Environmental Protocol [22]. NEP aims at measuring the endorsement of an ecological worldview. The revised version lies in adding new items both relating to the concept of “human exceptionalism”, and in addressing the environmental crisis with the concepts of “balance of nature”, “limits to growth”, and “antanthropocentrism” (that were already included). NEP scale measures fundamental beliefs about the environment; it is a widely used scale for environmental concerns [32]. However, NEP measures cognitive beliefs rather than affective and experiential relationships to the environment [49]. As well, items describe beliefs about humans as a whole (e.g., “Humans have the right to modify the natural environment to suit their needs”, or “We are approaching the limit of the number of people that Earth can support”),

thus not considering a personal relationship with the environment. Nevertheless, NEP is one of the most common scales [78].

5.2 Emotional Affinity Toward Nature Scale

EATN [36] aims to “measure an emotion that develops through experiences with nature during childhood” [51]. Unlike NEP, this scale covers aspects related to love of nature, feelings of freedom in nature, security in nature, and oneness with nature. This scale is one of the most frequently cited scales [85].

5.3 Inclusion of Nature in the Self

INS [72] measures users’ relationship with nature by asking to choose between seven pairs of overlapping circles that best represent respondents’ relationship with nature: one circle is for the “self”; the other is for the “nature”—the more the circles overlap, the more respondents feel connected to nature. However, such a level of abstraction prevents reporting connection with nature accurately [49]. Martin and Czellar [47] developed an extended version of INS with four items and more possible answers through the size of circles and how the circles are centered between them. INS has been identified as useful to practitioners [67].

5.4 Environmental Identity Scale

EID [10] is designed to measure the sense of connection with nature that respondents feel, or “a person’s self-understanding as an integrated component of the natural environment” [11]. Unlike the other scales presented above, EID focuses more on self-perceived identity. A revised version of EID was developed during a study involving several countries and cultures [11]. This scale is useful to practitioners [67].

5.5 Modified Implicit Associations Test

Schultz et al. [73] propose a computer-based test to measure Connectedness to Nature with automatic concept-attribute associations times—this test is based on the Implicit Association Test (IAT) [30]. The test consists in displaying a series of words: for each word, respondents have to quickly identify whether it is 'natural' or 'built', 'self' or 'other'. The test measures associations' reaction time of correct concepts' pairs. For example, if the word "ANIMAL" is displayed, the user has to choose between "NATURAL" or "BUILT". The correct answer is "NATURAL". If the word "MINE" is displayed, the user has to choose between "BUILT OR ME" or "NATURE OR NOT ME". The correct answer is "BUILT OR ME".

5.6 Connectedness to Nature Scale

CNS [49] measures respondents' affective and experiential connection to nature. Items describe place in nature and feelings of closeness with all the living entities. CNS was designed to measure affective dimensions (unlike NEP, INS, and IAT scales). An adaptation of this scale (a 14-item scale called CNI, Connection to Nature Index) is available for children [9]. This scale is widely used by researchers [85] and is useful to practitioners [67].

5.7 Nature Relatedness Scale

NRS [54] is designed similarly to CNS to measure individual levels of Connectedness to Nature. However, unlike CNS, the concept of nature relatedness includes the physical relationship aspect (physical experience and contact) in addition to the cognitive and affective relationship with nature. Nisbet et al. consider NRS as relatively stable over time [54]. A short-form version of NRS (NR-6) is composed of six items [53]. NRS is useful to practitioners [67].

5.8 Love and Care for Nature Scale

LCN [57] measures the love and care for nature concept, defined as "*deep love and caring for nature which includes a clear recognition of nature's intrinsic value as well as a personal sense of responsibility to protect it from harm*". This scale is useful to practitioners [67].

6 CORPUS ANALYSIS

Tables 4, 5, and 6 examine the 21 corpus scales through their psychological constructs, targeted audience, and items, respectively. This section analyzes how the corpus covers the eight criteria.

6.1 Point of View

As Table 4 shows, sixteen of the 21 scales measure an individual sense of Connectedness to Nature (76%): only two scales use "aggregate" type of items (NEC and NEP); two use "concept" type of items (EVO and IAT); and one uses the "portrait" type (E-PVQ).

6.2 Construct Dimensions

Affect and motives toward nature are measured by most of the corpus scales (14 of 21, 67%). Beliefs and environmental identity are both covered by items of twelve out of 21 questionnaires (57%). Only three scales cover more than four Connectedness to Nature dimensions (14%); four scales cover only one dimension (19%). NRS' construct is the most complete in view of dimensions: it is the

only scale to cover all dimensions; it considers the behavioral dimension through physical experience and contact with nature in addition to the four other dimensions—some other scales consider the behavioral dimension but do not consider all other dimensions (e.g., EATN, EID, and LCN). IAT measures the extent to which respondents associate implicitly "self" with "nature" (knowledge, beliefs, and identity dimensions). DENS and EMS focus instead on affective relationships or motives toward the environment; HARN and DCN, environmental activities; and INS and AID, environmental identity aspects. Scales constructs' dimensions are reported in Table 4.

6.3 Age Groups and Languages

We restricted our corpus to scales usable with adults at least. However, several of these scales are also available for other age groups: because the original questionnaire was designed this way (INS, EID, NRS, LCN, and DCN), or because an adapted version was later published (EATN, NEP, IAT, and CNS). Scales' age groups are reported in Table 5.

All the scales were originally published in English. We found published translations of their questionnaires for the following four languages, but we failed to find some in Italian:

- French: NEP [68], EID [60], and CNS [52];
- Spanish: EAATE [74], EMS [20, 71], EID [11, 55], CNS [55], NRS [20], DENS [75], and E-PVQ [20];
- German: EAATE [76], NEP [69], EMS [20], NRS [20], and E-PVQ [20];
- Portuguese: CNS [58] and LCN [50].

The most available scale through languages is CNS, with four languages: English, French, Spanish, and Portuguese. Translations must, however, be used carefully: for example, Pasca et al. [56] show that CNS's Spanish version of Olivos et al. [55]—a back-translated one—is not equivalent to the original English version. Scales' available languages are reported in Table 5.

6.4 Consistency and Measurement

Questionnaires' internal consistency is provided for nearly three-quarters of the scales (15 of 21, 71%): Table 6 gives Cronbach's alpha coefficients for whole questionnaires or by items' categories. Most corpus scales were reported a good internal consistency in their original publication ($\alpha > .70$ as recommended by [42]). Exceptions are the following: EAATE ($\alpha = .67$ for anthropocentrism), EVO ($\alpha = .62$ for openness to change, $\alpha = .65$ for conservation values, $\alpha = .65$ for altruistic values, and $\alpha = .67$ for self-enhancement), and E-PVQ ($\alpha = .68$ for altruistic values).

Two-thirds of corpus scales use Likert scales (14 of 21, 67%): over half of these scales are measured on five points (8 of 14, 57%); over one-third, on seven points (5 of 14, 36%); only one uses 9-point Likert scales (1 of 14, 7%). Whereas some work suggests better data quality with 7-point scales, no effect was found on NEP scores [32]. Some work combines measurement kinds, such as CWN, which uses four Likert scales and one Venn Diagram item based on INS. Some other work, such as AID, uses only Venn Diagrams. Then, E-PVQ asks participants to position themselves according to statements (i.e., a portrait). DCN asks about behaviors using Yes/No questions and frequency scales. HARN—based on DCN—also integrates Yes/No

Table 4: Psychological constructs of the 21 scales of the corpus.

# Scale	PoV	Construct Dimensions					Topic
		K	Bl	AM	Bh	Id	
1. EAATE	I	×	×	×	×	-	Ecocentric attitude (intrinsic values related to the appreciation of the environment), Anthropocentric attitude (extrinsic values related to comfort and survival of humans), and Environmental apathy (the lack of awareness about environmental issues).
2. PRS	I	-	-	×	×	×	Being Away, Fascination, Coherence, and Compatibility.
3. NEC	A	×	×	-	-	-	Future environmental, overpopulation, and economic crisis.
4. EVO/E-SVS	C	-	×	-	×	×	Egoistic, altruistic, and biospheric value orientations.
5. EATN/EAN	I	-	-	×	×	-	Emotional connection to his or her natural environment.
6. NEP	A	×	×	-	-	-	Endorsement of an ecological worldview.
7. EMS	I	-	-	×	-	-	Environmental motives about self (egoistic concerns), other people and future generations (altruistic concerns), and the biosphere (environment concerns).
8. INS	I	-	-	-	-	×	Feeling of connection to the environment.
9. EID/EIS	I	-	×	×	×	×	Self-understanding of being an integrated component of the natural environment.
10. IAT	C	×	×	-	-	×	Implicit association of the self and nature.
11. CNS/CTN (CNI)	I	-	×	×	-	×	Closeness with all the living entities of the environment and own place within the environment.
12. HARN	I	-	-	×	×	-	Specific behaviors that people differentially engage related to their connectedness with nature.
13. CWN/CwNS/ECS	I	-	×	×	-	×	Experiencing nature as being part of the same community.
14. AID	I	-	-	-	-	×	Connection to people, animals and inanimate objects.
15. COM	I	-	×	×	-	×	Attachment and long term orientation toward the environment.
16. NRS/NR	I	×	×	×	×	×	Connectedness with the environment (including physical contact).
17. LCN	I	-	-	×	×	×	Love and caring (responsibility) for nature.
18. DCN	I	-	-	×	×	-	Behavior and feelings toward animals and outside activities.
19. EAATSD	I	×	×	×	-	-	Ecocentric, anthropocentric attitude, and apathy toward the environment.
20. DENS	I	-	-	×	-	-	Empathy when animals suffer.
21. E-PVQ	P	-	×	-	×	×	Biospheric, altruistic, hedonic, and egoistic values.

Notes. '-' = empty; 'PoV' = Point of View: 'A' = Aggregate; 'I' = Individual; 'P' = Portrait; 'C' = Concept. Construct Dimensions: 'K' = Knowledge; 'Bl' = Beliefs (including worldview); 'AM' = Affect (e.g., emotions, feelings) and Motives; 'Bh' = Behavior (actions, experience, or physical contact with nature); and 'Id' = Identity (inclusion of nature in self and values).

Table 5: Targeted audiences of the 21 scales of the corpus.

# Scale	Age Group			Language					
	A	T	C	EN	FR	SP	IT	GE	PT
1. EAATE	o	-	-	o	-	d	-	v	-
2. PRS	o	-	-	o	-	-	-	-	-
3. NEC	o	-	-	o	-	-	-	-	-
4. EVO/E-SVS	o	-	-	o	-	-	-	-	-
5. EATN/EAN	o	a	-	o	-	-	-	-	-
6. NEP	o	-	a	o	v	-	-	v	-
7. EMS	o	-	-	o	-	b	-	b	-
8. INS	o	o	o	o	-	-	-	-	-
9. EID/EIS	o	o	-	o	v	v	-	-	-
10. IAT	o	-	a	o	-	-	-	-	-
11. CNS/CTN (CNI)	o	o	a	o	v	b	-	-	v
12. HARN	o	-	-	o	-	-	-	-	-
13. CWN/CwNS/ECS	o	-	-	o	-	-	-	-	-
14. AID	o	-	-	o	-	-	-	-	-
15. COM	o	-	-	o	-	-	-	-	-
16. NRS/NR	o	o	o	o	-	b	-	b	-
17. LCN	o	o	-	o	-	-	-	-	d
18. DCN	o	-	o	o	-	-	-	-	-
19. EAATSD	o	-	-	o	-	-	-	-	-
20. DENS	o	-	-	o	-	v	-	-	-
21. E-PVQ	o	-	-	o	-	b	-	b	-

Notes. '-' = empty. Age group: 'A' = Adults; 'T' = Teenagers; 'C' = Children; o = original article; a = adapted in further article. Language: 'EN' = English; 'FR' = French; 'SP' = Spanish; 'IT' = Italian; 'GE' = German; 'PT' = Portuguese; o = original version; v = validated translation (listed in Table 2's references); b = back-translation (listed in Table 2's references); d = direct-translation.

questions. Finally, IAT uses an original measure compared to other scales: word associations' response time. Scales' measurements are reported in Table 6.

6.5 Questionnaire Administration

As average times to take questionnaires were not estimated, this section examines questionnaires administration regarding the reading times and items counts that are reported in Table 6.

The average estimated reading time is 57.6 seconds (on 18 of the 21 questionnaires). The three longest scales to read are EAATE, DCN, and EAATSD (1'55, 1'45, and 1'33, respectively), making them less adequate to administer when recruiting participants in public places—where people have only a little time to spend on a user study. The fastest scale to read is EMS, taking only 6 seconds. All the items of this scale are associated to the same starting sentence: *"I am concerned about environmental problems because of the consequences for [...]"*. Then, this sentence has to be achieved twelve times with each of the following words: *"Plants"*, *"Me"*, *"People in my country"*, *"Marine life"*, *"My lifestyle"*, *"All people"*, *"Birds"*, *"My health"*, *"Children"*, *"Animals"*, *"My future"*, and *"My children"*. However, each of EMS's twelve items has to be rated on a 7-point importance scale. Moreover, estimated reading time does not consider time for cognitive analysis, decision, and motoric tasks required to answer the questionnaires.

The number of items ranges from 1 to 40, with an average of 17.2 items (on 20 of the 21 questionnaires). Only INS has one item: it takes the form of Venn Diagrams. Apart from INS, the scale with

Table 6: Items and measurement of the 21 scales of the corpus.

# Scale	Normal version			Short version			Measurement		
	#Items	Time ⁽¹⁾	Alpha ⁽²⁾	#Items	Time ⁽¹⁾	Alpha ⁽²⁾	L.S.	Y/N	Other
1. EAATE	30	1'55"	.67, .78, .82	-	-	-	5 pts	-	-
2. PRS	26	1'08"	n.c.	-	-	-	7 pts	-	-
3. NEC	10	40"	.83	-	-	-	7 pts	-	-
4. EVO/E-SVS	16	24"	.62, .65, .65, .67, .84	-	-	-	-	-	Importance Scales (9 pts)
5. EATN/EAN	16	1'18"	.74, .80–.92, .84–.93	-	-	-	6 pts	-	-
6. NEP	15	43"	.83	-	-	-	5 pts	-	-
7. EMS	12	6"	.78, .83, .92	-	-	-	-	-	Importance Scales (7 pts)
8. INS	1	n.a.	n.a.	-	-	-	-	-	Venn Diagrams (7 pts)
9. EID/EIS	14	58"	.92	-	-	-	-	-	Identity Scales (7 pts)
10. IAT	n.a.	n.a.	n.a.	-	-	-	-	-	Association times (Words)
11. CNS/CTN (CNI)	14	1'02"	.84	-	-	-	5 pts	-	-
12. HARN	33	1'24"	.88	-	-	-	5 pts	×	Frequency Scales (5pts)
13. CWN/CwNS/ECS	5	23"	.72	-	-	-	5 pts	-	Venn Diagrams (3 pts)
14. AID	16	41"	n.c.	-	-	-	-	-	Venn Diagrams (7 pts)
15. COM	11	39"	.91	-	-	-	9 pts	-	-
16. NRS/NR	21	1'06"	.87	6	17"	.83–.86	5 pts	-	-
17. LCN	15	52"	.97	-	-	-	5 pts	-	-
18. DCN	40	1'45"	n.c.	-	-	-	-	×	Frequency Scales (3 pts)
19. EAATSD	22	1'33"	n.c.	-	-	-	5 pts	-	-
20. DENS	10	40"	>.90	-	-	-	7 pts	-	-
21. E-PVQ	17	47"	.68, .71, .78, .88	-	-	-	-	-	Portrait Scales (7 pts)

Notes. '-' = empty; 'Alpha' = Cronbach's alpha (ρ_T); 'L.S.' = Likert Scales; 'Y/N' = Yes/No Questions; n.c. = not calculated; n.a. = not applicable.

⁽¹⁾ Questions' reading time (not including the instructions) of the English version, estimated using an online tool with 200 words per minute rate (<https://niram.org/read>, accessed 2022-02-07).

⁽²⁾ Several values are given when internal consistency is calculated by items' categories.

the least number of items is CWN (five items). Nevertheless, the fifth item is a series of three Venn diagrams indicating the extent to which respondents feel that they and nature are the same. The scale with the third-lowest number of items is NR-6, the short version of NRS. The three scales with the highest number of items are EAATE, HARN, and DCN (with 30, 33, and 40 items, respectively), but no short versions are provided: the only short version available for corpus scales is NR-6. Finally, IAT's consists of 70 association measures; however, IAT is a computerized test that should require concentration and quietness—to better measure response times—and may be challenging to administer in public areas.

7 EXPERIMENTAL VALIDATIONS

Beyond meta-information provided by scale characteristics and analysis through criteria, scales' experimental comparisons provide information about their validity and reliability (i.e., the predictive power of environmental beliefs and behaviors). This section reviews experimental validation and comparisons of CNS, IAT, NRS, EID, LCN, E-PVQ, EVO, NEP, and cultural cognition scales.

Several contributions show that CNS is a reliable predictor of environmentally responsible behavior (e.g., see the review of Zylstra et al. [85]). Geng et al. [29] show that IAT predicts spontaneous behaviors, whereas CNS predicts deliberate behaviors related to the environment. NRS, EID, and LCN are also shown as reliable predictors of environmental behavior [81]. When introducing E-PVQ, Bouman et al. [5] compared it to EVO. Whereas they showed the two scales are valid and reliable, the respondents slightly preferred the E-PVQ portrait scale over EVO (for ease, clarity, and comprehensibility).

Sparks et al. [78] compared NEP, CNS, EID, and cultural cognition scales—the cultural cognition scales measure people's concern for risk based on their cultural background. They found that CNS and EID are strong predictors of pro-environmental behavior. More precisely, they found a better predictive power of environmental behaviors for CNS and EID over NEP and cultural cognition. Whereas EID predicted slightly better public behaviors, CNS better predicted private behaviors.

8 MAKING A CHOICE

This section exposes our choices to measure Connectedness to Nature in future user studies. These studies will evaluate the effect of some SHCI-TD interfaces on users' behavior at workplaces, and the impact of some others on users' thinking in public places. Because participants' level of Connectedness to Nature may affect attitudinal and behavioral change observations, we want to measure this level as an independent variable of our user studies as it can influence participants' environmental behavior.

8.1 Longitudinal User Studies at Workplaces

CNS is the first choice for our user studies at the workplace. CNS captures the three dimensions of beliefs, affect and motives, and identity. Physical contact dimension is not measured but may not be relevant for the users we consider. The questionnaire asks participants to position themselves according to first-person assertions (using Likert scales). Among the corpus, only E-PVQ and IAT attempt to reduce biases related to self-representation contentiousness. However, E-PVQ is not available in French, and including a computerized association test such as IAT—among other questions—may be intrusive. CNS's authors reported a good

internal consistency of the questionnaire ($\alpha = .84$). Versions of CNS can be found for all three age groups. CNS's length is only in the corpus average, but the estimated reading time of 1'02 and the 14 items to fill out can fit for longitudinal studies where time is planned. An alternative scale could be EID because of reliability ($\alpha = .92$), diversity of the four measured dimensions (beliefs, affect and motives, behavior, and identity), and a medium administration time (14 items, 58-second reading time) equivalent to CNS. Finally, both CNS and EID are available through validated French versions for our user studies in France.

8.2 User Studies Recruiting in Public Places

Only three scales are available for all three age groups: INS, CNS, and NRS. The one-item INS scale is not reliable [49]. CNS's reading time (1'02) is only in the corpus average (57.6"), and no short version is available. NRS would then be the first choice for user studies in public spaces. NRS captures all the dimensions of Connectedness to Nature. Like CNS, respondents have to position themselves according to first-person affirmations. However, NRS has a validated short version: the fewer items of NR-6 may not capture all thoughts of the construct dimensions, but it does not "significantly compromise the reliability or validity" of the scale [53]. Both the 21-item and the 6-item versions of NRS were reported to have good internal consistencies. Versions of NRS can be found for all three age groups—such availability is convenient for user studies in public places. However, no validated translation of NRS is available in French: we could not use it for further user studies.

9 ANALYSIS OF SCALES' LIMITATIONS

Several limitations appear when choosing a questionnaire for HCI needs. This section analyses and summarizes those limitations regarding our criteria.

9.1 Construct

Although a portrait scale is slightly preferred over a concept scale for ease, clarity, and comprehensibility [5] and reduces biases related to self-representation contentiousness, three-quarter of corpus scales uses individual point of view (see Figure 3a). Furthermore, whereas some corpus constructs focus on one dimension, most focus on two or three, and only a few cover more than four (see Figure 3b). However, these constructs were not designed for HCI user study concerns: the correct dimensions to consider are unknown.

9.2 Audience

Many questionnaires focus on limited ranges of audiences and contexts [67]. For example, only three scales of the corpus are available for all three age groups (INS, CNS, and NRS), and over half are available for one age group only (see Figure 3c). Adapting or designing more scales covering all audiences would be valuable for HCI user studies.

The corpus questionnaires' availability is very low through the six languages we examine (English, French, Spanish, Italian, German, and Portuguese): all are originally published in English; not enough are translated in other languages (e.g., none is available in Italian). Only one scale is available in up to four languages (CNS);

six in three languages; two in two languages; and over half were not translated (see Figure 3d). Moreover, only half of those translations are validated ones (8 of 17, 47%), even though the back-translation procedure can result in questionnaires nonequivalent to the original one [56] and direct translations receive no verification at all.

9.3 Measurement

Getting overall measures of Connectedness to Nature is useful as ANOVA's variables and as scores to gauge groups between studies. However, no corpus scale explicitly provides a calculation formula—neither for an overall value nor by items' categories. Though the calculation is trivial for homogeneous scales using only Likert scales, importance scales, frequency scales, or portrait scales, getting meaningful values is less evident for heterogeneous scales combining several measurements' kind or unlike numbers of points. Items' measurement ranges from Likert scales to identity scales, sets diagrams, portrait scales, Venn diagrams, frequency scales, word associations, importance scales, and Yes/No questions. Ensuring standard scale calculation would be valuable to compare results between user studies.

9.4 Administration Time

Questionnaires' administration time can be approximated from information such as items' count, measurement's kind, and questions' reading time. We estimated that the longest questions' reading time (nearly 120 seconds) is ten times the shortest ones (a dozen seconds): reading time ranges from less than 30 seconds (3 scales) to nearly 120 seconds (3 scales beyond 1'30), and over half of questionnaires takes from 30" to 1'30 reading time (11 scales). Scales' distribution by reading time ranges is showed in Figure 3e. Knowing average administration times to take tests would be valuable criteria when designing user studies: those times should be measured for the corpus scales and new scales when published.

A way to decrease administration time is to decrease items count by removing some items: only five scales comprise less than ten items (see scales distribution by items count range in Figure 3f). For example, one scale of the corpus (NRS) proposes a validated short version that decreases the number of items by 71% and reading time by 74%. Some work shortened scales for their needs by combining subsets of items, but items' choice and count vary [32], thus preventing comparisons between studies. Developing and validating more short versions would be valuable for HCI user studies, especially when high administration time.

10 DISCUSSION

Environmental psychologists designed many Connectedness to Nature scales for social sciences concerns to better understand humans' relationship with the environment. However, the number of possible questionnaires is relatively low once filtered through criteria for SHCI user studies analysis needs, preventing driving the final choice according to the psychological construct, the internal validity, and the predictive power.

Connectedness to Nature's scales should be available in languages that allow researchers and practitioners to conduct user studies in their cities and countries. Having more translations with cultural validation is necessary to get questionnaires covering, at

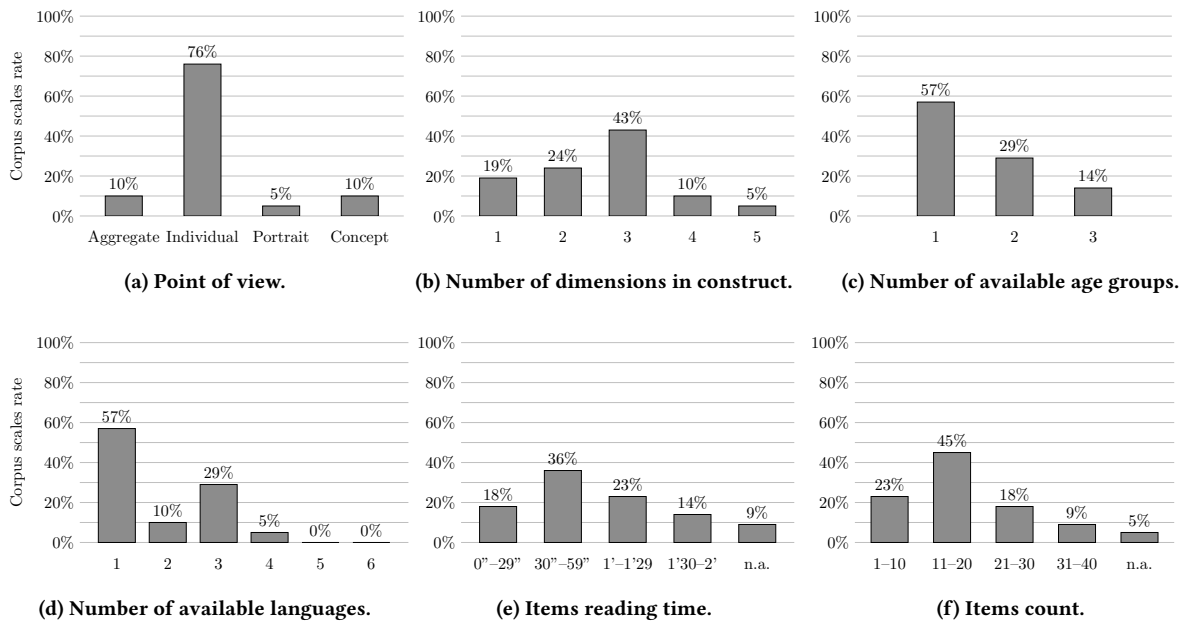


Figure 3: Corpus scales' distribution through six of our eight criteria.

Note. n.a. = not applicable.

least, countries with high greenhouse gases (GHG) emissions. As Sustainable HCI systems can target users of any age group, adapting or designing more scales that cover all audiences would be valuable for user studies, especially in public places.

Evaluating Sustainable HCI systems requires asking questions beyond Connectedness to Nature, such as usability and user experience. Hence, developing and validating short versions would be valuable for HCI user studies, especially when questionnaires' administration time is high. Moreover, knowing the average administration times to take tests would be valuable information to researchers and practitioners when designing user studies; according to the context of the study, users can have little time to spend or become bored by the repetition of long questionnaires.

Furthermore, the evaluation of Sustainable HCI systems through longitudinal user studies, in several countries, by several researchers and practitioners, may result in several studies across time. Comparing these studies' results is possible only if groups' Connectedness to Nature is known. Therefore, ensuring that researchers and practitioners use scores calculated the same way is necessary for result comparisons between user studies.

SHCI user studies need at least one questionnaire measuring Connectedness to Nature available through languages and age groups, requiring short administration time, providing good internal consistency, good predictive power, and a calculation formula guaranteeing a standard overall measure. Researchers and practitioners could then all use it across countries, thus allowing results comparison between user studies. An inspiring example from HCI should be the User Experience Questionnaire 8-item short version, UEQ-S [70], that measures two qualities normalized in the -3 pts to 3 pts range and is available in more than 30 languages³.

³User Experience Questionnaire: <https://www.ueq-online.org/> (accessed 2022-02-07).

11 CONCLUSION

Sustainable HCI *through* Design (SHCI-TD) can benefit from standardized Connectedness to Nature (CtN) measures for user study analyses. This paper attempts to make Connectedness to Nature measures accessible for SHCI-TD user studies: we hope it will help other HCI researchers select tools for their user studies. First, we present a corpus of 21 self-report tools selected from previous systematic literature reviews and our own literature review. Next, we examine these tools through eight criteria based on questionnaires' characteristics and Sustainable HCI *through* Design user studies needs. Finally, we illustrate with questionnaire choices for two cases: CNS or EID for longitudinal user studies at workplaces; NRS's 6-item version for user studies recruiting in public places. Our future work will integrate one questionnaire in a longitudinal user study on using shape-changing interfaces as eco-feedback displays at the workplace. These interfaces will display renewable energy production peaks to enable participants to modify their use of electric appliances during work hours. This study will focus on studying behaviors' alignment with renewable energy production in collaboration with an autonomous shape-changing system. Environmental psychologists designed Connectedness to Nature scales first for social sciences concerns to better understand humans' relationship with the environment. A potential future work for research communities is to adapt these tools to HCI domain needs (e.g., validated translations, standardized overall values, estimated administration time, and short versions). Such tools would also help—beyond the development phase's user studies—to create profiles that serve parametrizing and customizing systems' content and objectives according to users' Connectedness to Nature level.

REFERENCES

- [1] Ernesto Arroyo, Leonardo Bonanni, and Ted Selker. 2005. Waterbot: Exploring Feedback and Persuasive Techniques at the Sink. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Portland, Oregon, USA) (CHI '05). Association for Computing Machinery, New York, NY, USA, 631–639. <https://doi.org/10.1145/1054972.1055059>
- [2] Danielle Bashan, Agathe Colléony, and Assaf Shwartz. 2021. Urban versus rural? The effects of residential status on species identification skills and connection to nature. *People and Nature* 3, 2 (April 2021), 347–358. <https://doi.org/10.1002/pan3.10176>
- [3] Sieto D. Beckers. 2005. *Measuring People's Connection with Nature: Exploring the Relations Between People's Implicit Connection with Nature, Their Explicit Conservation Behavior, and Their Affiliation with Technology*. Master's thesis. Technische Universiteit Eindhoven.
- [4] Eli Blevis. 2007. Sustainable Interaction Design: Invention & Disposal, Renewal & Reuse. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (San Jose, California, USA) (CHI '07). Association for Computing Machinery, New York, NY, USA, 503–512. <https://doi.org/10.1145/1240624.1240705>
- [5] Thijs Bouman, Linda Steg, and Henk A. L. Kiers. 2018. Measuring Values in Environmental Research: A Test of an Environmental Portrait Value Questionnaire. *Frontiers in Psychology* 9, Article 564 (April 2018), 15 pages. <https://doi.org/10.3389/fpsyg.2018.00564>
- [6] Adrian Brügger, Florian G. Kaiser, and Nina Roczen. 2011. One for all? Connectedness to Nature, Inclusion of Nature, Environmental Identity, and Implicit Association with Nature. *European Psychologist* 16, 4 (Dec. 2011), 324–333. <https://doi.org/10.1027/1016-9040/a000032>
- [7] Coral M. Bruni and P. Wesley Schultz. 2010. Implicit beliefs about self and nature: Evidence from an IAT game. *Journal of Environmental Psychology* 30, 1 (March 2010), 95–102. <https://doi.org/10.1016/j.jenvp.2009.10.004>
- [8] Hronn Brynjarsdóttir, Maria Håkansson, James Pierce, Eric Baumer, Carl DiSalvo, and Phoebe Sengers. 2012. Sustainably Unpersuaded: How Persuasion Narrows Our Vision of Sustainability. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Austin, Texas, USA) (CHI '12). Association for Computing Machinery, New York, NY, USA, 947–956. <https://doi.org/10.1145/2207676.2208539>
- [9] Judith Chen-Hsuan Cheng and Martha C. Monroe. 2012. Connection to Nature: Children's Affective Attitude Toward Nature. *Environment and Behavior* 44, 1 (Jan. 2012), 31–49. <https://doi.org/10.1177/0013916510385082>
- [10] Susan Clayton. 2003. Environmental identity: A conceptual and an operational definition. In *Identity and the Natural Environment: The Psychological Significance of Nature*, Susan Clayton and Susan Opatow (Eds.). MIT Press, Cambridge, MA, USA, Chapter 3, 45–65. <https://doi.org/10.7551/mitpress/3644.003.0005>
- [11] Susan Clayton, Sandor Czellar, Sonya Nartova-Bochaver, Jeffrey C. Skibins, Gabby Salazar, Yu-Chi Tseng, Boris Irkhin, and Fredy S. Monge-Rodriguez. 2021. Cross-cultural Validation of A Revised Environmental Identity Scale. *Sustainability* 13, 4, Article 2387 (Feb. 2021), 12 pages. <https://doi.org/10.3390/su13042387>
- [12] John Cook, Naomi Oreskes, Peter T. Doran, William R.L. Anderegg, Bart Verheggen, Ed W. Maibach, J. Stuart Carlton, Stephan Lewandowsky, Andrew G. Skuce, Sarah A. Green, et al. 2016. Consensus on consensus: a synthesis of consensus estimates on human-caused global warming. *Environmental Research Letters* 11, 4, Article 048002 (April 2016), 7 pages. <https://doi.org/10.1088/1748-9326/11/4/048002>
- [13] Maxime Daniel and Guillaume Rivière. 2021. Exploring Axisymmetric Shape-Change's Purposes and Allure for Ambient Display: 16 Potential Use Cases and a Two-Month Preliminary Study on Daily Notifications. In *Proceedings of the Fifteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Salzburg, Austria) (TEI '21). Association for Computing Machinery, New York, NY, USA, Article 47, 6 pages. <https://doi.org/10.1145/3430524.3442452>
- [14] Maxime Daniel, Guillaume Rivière, and Nadine Couture. 2019. CairnFORM: A Shape-Changing Ring Chart Notifying Renewable Energy Availability in Peripheral Locations. In *Proceedings of the Thirteenth International Conference on Tangible, Embedded, and Embodied Interaction* (Tempe, Arizona, USA) (TEI '19). Association for Computing Machinery, New York, NY, USA, 275–286. <https://doi.org/10.1145/3294109.3295634>
- [15] Maxime Daniel, Guillaume Rivière, Nadine Couture, and Stéphane Kreckelbergh. 2016. Une analyse des Systèmes Interactifs et Persuasifs pour la maîtrise de l'énergie / An analysis of persuasive technologies for energy demand side management. In *Actes de la 28e conférence francophone sur l'Interaction Homme-Machine* (Fribourg, Switzerland). ACM Press, New York, NY, USA, 197–210. <https://doi.org/10.1145/3004107.3004111>
- [16] Jody L. Davis, Jeffrey D. Green, and Allison Reed. 2009. Interdependence with the environment: Commitment, interconnectedness, and environmental behavior. *Journal of Environmental Psychology* 29, 2 (June 2009), 173–180. <https://doi.org/10.1016/j.jenvp.2008.11.001>
- [17] Judith I.M. De Groot and Linda Steg. 2007. Value Orientations and Environmental Beliefs in Five Countries: Validity of an Instrument to Measure Egoistic, Altruistic and Biospheric Value Orientations. *Journal of Cross-Cultural Psychology* 38, 3 (May 2007), 318–332. <https://doi.org/10.1177/0022022107300278>
- [18] Philippe Descola. 1996. Constructing natures: symbolic ecology and social practice. In *Constructing Natures*, Philippe Descola and Gisli Palsson (Eds.). Routledge, London, UK, Chapter 5, 82–102. <https://doi.org/10.4324/9780203451069>
- [19] Carl DiSalvo, Phoebe Sengers, and Hronn Brynjarsdóttir. 2010. Mapping the landscape of sustainable HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Atlanta, Georgia, USA) (CHI '10). Association for Computing Machinery, New York, NY, USA, 1975–1984. <https://doi.org/10.1145/1753326.1753625>
- [20] Maximilian Dornhoff, Jan-Niklas Sothmann, Florian Fiebelkorn, and Susanne Menzel. 2019. Nature Relatedness and Environmental Concern of Young People in Ecuador and Germany. *Frontiers in Psychology* 10, Article 453 (March 2019), 13 pages. <https://doi.org/10.3389/fpsyg.2019.00453>
- [21] Paul Dourish. 2010. HCI and Environmental Sustainability: The Politics of Design and the Design of Politics. In *Proceedings of the 8th ACM Conference on Designing Interactive Systems* (Aarhus, Denmark) (DIS '10). Association for Computing Machinery, New York, NY, USA, 1–10. <https://doi.org/10.1145/1858171.1858173>
- [22] Riley E. Dunlap and Kent D. Van Liere. 1978. The "New Environmental Paradigm". *The Journal of Environmental Education* 9, 4 (July 1978), 10–19. <https://doi.org/10.1080/00958964.1978.10801875>
- [23] Riley E. Dunlap, Kent D. Van Liere, Angela G. Mertig, and Robert Emmet Jones. 2000. Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues* 56, 3 (2000), 425–442. <https://doi.org/10.1111/0022-4537.00176>
- [24] Daniel D. Dutcher, James C. Finley, AE Luloff, and Janet Buttolph Johnson. 2007. Connectivity With Nature as a Measure of Environmental Values. *Environment and Behavior* 39, 4 (July 2007), 474–493. <https://doi.org/10.1177/0013916506298794>
- [25] Richard J. Ellis and Fred Thompson. 1997. Culture and the Environment in the Pacific Northwest. *American Political Science Review* 91, 4 (Dec. 1997), 885–897. <https://doi.org/10.2307/2952171>
- [26] Julie Ernst and Stefan Theimer. 2011. Evaluating the effects of environmental education programming on connectedness to nature. *Environmental Education Research* 17, 5 (Oct. 2011), 577–598. <https://doi.org/10.1080/13504622.2011.565119>
- [27] Brian J. Fogg. 1998. Persuasive Computers: Perspectives and Research Directions. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Los Angeles, CA, USA) (CHI '98). ACM Press/Addison-Wesley Publishing Co., New York, NY, USA, 225–232. <https://doi.org/10.1145/274644.274677>
- [28] Jon Froehlich, Leah Findlater, Marilyn Osterberg, Solai Ramanathan, Josh Peterson, Inness Wragg, Eric Larson, Fabia Fu, Mazhengmin Bai, Shwetak Patel, and James A. Landay. 2012. The Design and Evaluation of Prototype Eco-Feedback Displays for Fixture-Level Water Usage Data. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Austin, Texas, USA) (CHI '12). Association for Computing Machinery, New York, NY, USA, 2367–2376. <https://doi.org/10.1145/2207676.2208397>
- [29] Liuna Geng, Jingke Xu, Lijuan Ye, Wenjun Zhou, and Kexin Zhou. 2015. Connections with Nature and Environmental Behaviors. *PloS One* 10, 5, Article e0127247 (May 2015), 11 pages. <https://doi.org/10.1371/journal.pone.0127247>
- [30] Anthony G. Greenwald, Debbie E. McGhee, and Jordan L.K. Schwartz. 1998. Measuring individual differences in implicit cognition: the implicit association test. *Journal of Personality and Social Psychology* 74, 6 (June 1998), 1464–1480. <https://doi.org/10.1037/0022-3514.74.6.1464>
- [31] Terry Hartig, Florian G. Kaiser, and Peter A. Bowler. 1997. *Further development of a measure of perceived environmental restorativeness*. Technical Report "Working Paper No. 5". Institute for Housing Research, Uppsala Universitet, Gävle, Sweden.
- [32] Lucy J. Hawcroft and Taciano L. Milfont. 2010. The use (and abuse) of the new environmental paradigm scale over the last 30 years: A meta-analysis. *Journal of Environmental Psychology* 30, 2 (June 2010), 143–158. <https://doi.org/10.1016/j.jenvp.2009.10.003>
- [33] Lorenz Hilty, Wolfgang Lohmann, and Elaine M. Huang. 2011. Sustainability and ICT – An overview of the field. *Notizie di Politeia XXVII*, 104 (2011), 13–28. <https://doi.org/10.5167/uzh-55640>
- [34] Florian G. Kaiser and Mark Wilson. 2004. Goal-directed conservation behavior: The specific composition of a general performance. *Personality and Individual Differences* 36, 7 (May 2004), 1531–1544. <https://doi.org/10.1016/j.paid.2003.06.003>
- [35] Florian G. Kaiser, Sybille Wöfling, and Urs Fuhrer. 1999. Environmental attitude and ecological behaviour. *Journal of Environmental Psychology* 19, 1 (March 1999), 1–19. <https://doi.org/10.1006/jenvp.1998.0107>
- [36] Elisabeth Kals, Daniel Schumacher, and Leo Montada. 1999. Emotional Affinity toward Nature as a Motivational Basis to Protect Nature. *Environment and Behavior* 31, 2 (March 1999), 178–202. <https://doi.org/10.1177/00139169921972056>
- [37] Samantha Keaulana, Melissa Kahili-Heede, Lorinda Riley, Mei Linn N Park, Kuaiwi Laka Makua, Jetney Kahaulailahi Vegas, and Mapuana CK Antonio. 2021. A Scoping Review of Nature, Land, and Environmental Connectedness and Relatedness. *International Journal of Environmental Research and Public Health* 18, 11, Article 5897 (May 2021), 30 pages. <https://doi.org/10.3390/ijerph18115897>

- [38] Bran Knowles. 2013. Re-Imagining Persuasion: Designing for Self-Transcendence. In *CHI '13 Extended Abstracts on Human Factors in Computing Systems* (Paris, France) (CHI EA '13). Association for Computing Machinery, New York, NY, USA, 2713–2718. <https://doi.org/10.1145/2468356.2479498>
- [39] Bran Knowles, Lynne Blair, Paul Coulton, and Mark Lochrie. 2014. Rethinking Plan A for Sustainable HCI. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Toronto, Ontario, Canada) (CHI '14). Association for Computing Machinery, New York, NY, USA, 3593–3596. <https://doi.org/10.1145/2556288.2557311>
- [40] Helen Kopnina. 2013. Evaluating education for sustainable development (ESD): Using Ecocentric and Anthropocentric Attitudes toward the Sustainable Development (EAATSD) scale. *Environment, Development and Sustainability* 15, 3 (June 2013), 607–623. <https://doi.org/10.1007/s10668-012-9395-z>
- [41] Stacey Kuznetsov and Eric Paulos. 2010. UpStream: Motivating Water Conservation with Low-Cost Water Flow Sensing and Persuasive Displays. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (Atlanta, Georgia, USA) (CHI '10). Association for Computing Machinery, New York, NY, USA, 1851–1860. <https://doi.org/10.1145/1753326.1753604>
- [42] Thomas K. Landauer. 1997. Behavioral Research Methods in Human-Computer Interaction. In *Handbook of Human-Computer Interaction* (2nd ed.), Marting G. Helander, Thomas K. Landauer, and Prasad V. Prabh (Eds.). North-Holland, Amsterdam, Chapter 9, 203–227. <https://doi.org/10.1016/B978-0-44481862-1.50075-3>
- [43] Lincoln R. Larson, Rachel Szczytko, Edmond P. Bowers, Lauren E. Stephens, Kathryn T. Stevenson, and Myron F. Floyd. 2019. Outdoor Time, Screen Time, and Connection to Nature: Troubling Trends Among Rural Youth? *Environment and Behavior* 51, 8 (Oct. 2019), 966–991. <https://doi.org/10.1177/0013916518806686>
- [44] Mark R. Leary, Jessica M. Tipsord, and Eleanor B. Tate. 2008. Allo-inclusive identity: Incorporating the social and natural worlds into one's sense of self. In *Transcending Self-Interest: Psychological Explorations of the Quiet Ego*. American Psychological Association, Washington, DC, USA, Chapter 13, 137–147. <https://doi.org/10.1037/11771-013>
- [45] Jennifer C. Mankoff, Eli Blevis, Alan Borning, Batya Friedman, Susan R. Fussell, Jay Hasbrouck, Allison Woodruff, and Phoebe Sengers. 2007. Environmental Sustainability and Interaction. In *CHI '07 Extended Abstracts on Human Factors in Computing Systems* (San Jose, CA, USA) (CHI EA '07). Association for Computing Machinery, New York, NY, USA, 2121–2124. <https://doi.org/10.1145/1240866.1240963>
- [46] Constantinos C. Manoli, Bruce Johnson, and Riley E. Dunlap. 2007. Assessing Children's Environmental Worldviews: Modifying and Validating the New Ecological Paradigm Scale for Use With Children. *The Journal of Environmental Education* 38, 4 (June 2007), 3–13. <https://doi.org/10.3200/JOEE.38.4.3-13>
- [47] Christian Martin and Sandor Czellar. 2016. The extended Inclusion of Nature in Self scale. *Journal of Environmental Psychology* 47 (Sept. 2016), 181–194. <https://doi.org/10.1016/j.jenvp.2016.05.006>
- [48] Valérie Masson-Delmotte, Panmao Zhai, Anna Pirani, Sarah L. Connors, C. Péan, Sophie Berger, Nada Caud, Y. Chen, Leah Goldfarb, Melissa I. Gomis, Mengtian Huang, Katherine Leitzell, Elisabeth Lonnoy, J. B. Robin Matthews, Thomas K. Maycock, Tim Waterfield, Özge Yelekçi, R. Yu, and Botao Zhou (Eds.). 2021. *Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge University Press, Cambridge, UK.
- [49] F. Stephan Mayer and Cynthia McPherson Frantz. 2004. The connectedness to nature scale: A measure of individuals' feeling in community with nature. *Journal of Environmental Psychology* 24, 4 (Dec. 2004), 503–515. <https://doi.org/10.1016/j.jenvp.2004.10.001>
- [50] Katarzyna Mikołajczak. 2019. *Understanding connection with nature at an Amazonian deforestation frontier*. Master's thesis. Lancaster University, UK.
- [51] Markus M. Müller, Elisabeth Kals, and Ramune Pansa. 2009. Adolescents' Emotional Affinity toward Nature: A Cross-Societal Study. *Journal of Developmental Processes* 4, 1 (Jan. 2009), 59–69.
- [52] Oscar Navarro, Pablo Olivos, and Ghozlane Fleury-Bahi. 2017. "Connectedness to Nature Scale": Validity and Reliability in the French Context. *Frontiers in Psychology* 8, Article 2180 (Dec. 2017), 8 pages. <https://doi.org/10.3389/fpsyg.2017.02180>
- [53] Elizabeth K. Nisbet and John M. Zelenski. 2013. The NR-6: a new brief measure of nature relatedness. *Frontiers in Psychology* 4, Article 813 (Nov. 2013), 11 pages. <https://doi.org/10.3389/fpsyg.2013.00813>
- [54] Elizabeth K. Nisbet, John M. Zelenski, and Steven A. Murphy. 2009. The Nature Relatedness Scale: Linking Individuals' Connection With Nature to Environmental Concern and Behavior. *Environment and Behavior* 41, 5 (Sept. 2009), 715–740. <https://doi.org/10.1177/0013916508318748>
- [55] Pablo Olivos, Juan I Aragonés, and María Américo. 2011. The Connectedness to Nature Scale and its relationship with environmental beliefs and identity. *International Journal of Hispanic Psychology* 4, 1 (Jan. 2011), 5–19.
- [56] Laura Pasca, María Teresa Coello, Juan Ignacio Aragonés, and Cynthia McPherson Frantz. 2018. The equivalence of measures on the Connectedness to Nature Scale: A comparison between ordinal methods of DIF detection. *PLOS One* 13, 11, Article e0207739 (Nov. 2018), 11 pages. <https://doi.org/10.1371/journal.pone.0207739>
- [57] Helen E. Perkins. 2010. Measuring love and care for nature. *Journal of Environmental Psychology* 30, 4 (Dec. 2010), 455–463. <https://doi.org/10.1016/j.jenvp.2010.05.004>
- [58] Viviany Silva Pessoa, Valdney Veloso Gouveia, Ana Karla Silva Soares, Roosevelt Vilar, and Leogildo Alves Freires. 2016. Escala de conexão com a natureza: evidências psicométricas no contexto brasileiro / Connectedness to nature scale: Psychometric evidence in Brazil. *Estudos de Psicologia (Campinas)* 33, 2 (April 2016), 271–282. <https://doi.org/10.1590/1982-02752016000200009>
- [59] James Pierce, Yolande Strengers, Phoebe Sengers, and Susanne Bødker. 2013. Introduction to the Special Issue on Practice-Oriented Approaches to Sustainable HCI. *ACM Trans. Comput.-Hum. Interact.* 20, 4, Article 20 (Sept. 2013), 8 pages. <https://doi.org/10.1145/2494260>
- [60] Anne-Caroline Prévot, Susan Clayton, and Raphael Mathevet. 2018. The relationship of childhood upbringing and university degree program to environmental identity: Experience in nature matters. *Environmental Education Research* 24, 2 (Feb. 2018), 263–279. <https://doi.org/10.1080/13504622.2016.1249456>
- [61] Christian Remy, Oliver Bates, Alan Dix, Vanessa Thomas, Mike Hazas, Adrian Friday, and Elaine M. Huang. 2018. Evaluation Beyond Usability: Validating Sustainable HCI Research. In *Proceedings of the 2018 CHI Conference on Human Factors in Computing Systems* (Montreal QC, Canada) (CHI '18). Association for Computing Machinery, New York, NY, USA, 1–14. <https://doi.org/10.1145/3173574.3173790>
- [62] Christian Remy, Oliver Bates, Vanessa Thomas, and Elaine M. Huang. 2017. The Limits of Evaluating Sustainability. In *Proceedings of the 2017 Workshop on Computing Within Limits* (Santa Barbara, California, USA) (LIMITS '17). Association for Computing Machinery, New York, NY, USA, 103–110. <https://doi.org/10.1145/3080556.3080567>
- [63] Brian Restall and Elisabeth Conrad. 2015. A literature review of connectedness to nature and its potential for environmental management. *Journal of Environmental Management* 159 (Aug. 2015), 264–278. <https://doi.org/10.1016/j.jenvman.2015.05.022>
- [64] Guillaume Rivière and Stephane Kreckelbergh. 2012. La StationENR pour sensibiliser aux énergies renouvelables par la modélisation de micro-réseaux [StationENR raises awareness on renewable energies by microgrids modeling]. In *Adjunct Proceedings of the 2012 Conference on Ergonomie et Interaction Homme-Machine* (Biarritz, France) (Ergo/IHM 2012 - Démonstrations). AFHIM, Grenoble, France, 63–66.
- [65] Guillaume Rivière. 2020. L'Interaction Homme-Machine contre le changement climatique : retour sur une controverse / Human-Computer Interaction against Climate Change: Review of a Controversy. *Journal d'Interaction Personne-Système* 9, 1 (Jan. 2020), 3–12. Issue on Persuasive Interaction for Sustainable Lity 2. <https://doi.org/10.46298/jips.7101>
- [66] G. Salazar, K. Kunkle, and M. C. Monroe. 2020. *Practitioner Guide to Assessing Connection to Nature*. North American Association for Environmental Education, Washington, DC.
- [67] Gabby Salazar, Martha C. Monroe, Catherine Jordan, Nicole M. Ardoin, and Thomas H. Beery. 2021. Improving Assessments of Connection to Nature: A Participatory Approach. *Frontiers in Ecology and Evolution* 8, Article 609104 (Jan. 2021), 7 pages. <https://doi.org/10.3389/fevo.2020.609104>
- [68] Alexandra Schleyer-Lindenmann, Bruno Dauvier, Heidi Ittner, and Michel Piolat. 2016. Mesure des attitudes environnementales: analyse structurale d'une version française de la NEPS (Dunlap et al., 2000) / Measuring environmental attitudes: A structural analysis of a French version of the NEP Scale (Dunlap et al., 2000). *Psychologie Française* 61, 2 (June 2016), 83–102. <https://doi.org/10.1016/j.psf.2014.07.002>
- [69] Alexandra Schleyer-Lindenmann, Heidi Ittner, Bruno Dauvier, and Michel Piolat. 2018. Die NEP-Skala-hinter den (deutschen) Kulissen des Umweltbewusstseins / The NEP Scale – behind the (German) scenes of environmental concern. *Diagnostica* 64, 3 (July 2018), 156–167. <https://doi.org/10.1026/0012-1924/a000202>
- [70] Martin Schrepp, Jörg Thomaschewski, and Andreas Hinderks. 2017. Design and Evaluation of a Short Version of the User Experience Questionnaire (UEQ-S). *International Journal of Interactive Multimedia and Artificial Intelligence* 4, 6 (Sept. 2017), 103–108. <https://doi.org/10.9781/ijimai.2017.09.001>
- [71] P. Wesley Schultz. 2001. The structure of environmental concern: Concern for self, other people, and the biosphere. *Journal of Environmental Psychology* 21, 4 (Dec. 2001), 327–339. <https://doi.org/10.1006/jevp.2001.0227>
- [72] P. Wesley Schultz. 2002. Inclusion with Nature: The Psychology Of Human-Nature Relations. In *Psychology of Sustainable Development*. Springer, Boston, MA, USA, Chapter 4, 61–78. https://doi.org/10.1007/978-1-4615-0995-0_4
- [73] P. Wesley Schultz, Chris Shriver, Jennifer J. Tabanico, and Azar M. Khazian. 2004. Implicit connections with nature. *Journal of Environmental Psychology* 24, 1 (March 2004), 31–42. [https://doi.org/10.1016/S0272-4944\(03\)00022-7](https://doi.org/10.1016/S0272-4944(03)00022-7)
- [74] P. Wesley Schultz and Lynette Zelezny. 1999. Values as predictors of environmental attitudes: Evidence for consistency across 14 countries. *Journal of Environmental Psychology* 19, 3 (Sept. 1999), 255–265. <https://doi.org/10.1006/jevp.1999.0129>

- [75] Verónica Sevillano, José A. Corraliza, and Esther Lorenzo. 2017. Spanish version of the Dispositional Empathy with Nature scale / Versión española de la escala de Empatía Disposicional hacia la Naturaleza. *Revista de Psicología Social* 32, 3 (Sept. 2017), 624–658. <https://doi.org/10.1080/02134748.2017.1356548>
- [76] Michael Siegrist. 1996. Fragebogen zur Erfassung der ökozentrischen und anthropozentrischen Umwelteinstellung / Questionnaire of ecocentric and anthropocentric attitudes toward the environment. *Zeitschrift für Sozialpsychologie* 27, 4 (1996), 290–294.
- [77] M. Six Silberman and Bill Tomlinson. 2010. Toward an Ecological Sensibility: Tools for Evaluating Sustainable HCI. In *CHI '10 Extended Abstracts on Human Factors in Computing Systems* (Atlanta, Georgia, USA) (CHI EA '10). Association for Computing Machinery, New York, NY, USA, 3469–3474. <https://doi.org/10.1145/1753846.1754003>
- [78] Aaron C. Sparks, Geoffrey L. Henderson, Shyam K. Sriram, and Eric R.A.N Smith. 2021. Measuring Environmental Values and Identity. *Society & Natural Resources* 34, 3 (March 2021), 291–310. <https://doi.org/10.1080/08941920.2020.1817644>
- [79] Paul C. Stern, Thomas Dietz, and Gregory A. Guagnano. 1998. A Brief Inventory of Values. *Educational and Psychological Measurement* 58, 6 (Dec. 1998), 984–1001. <https://doi.org/10.1177/0013164498058006008>
- [80] Yolande Strengers. 2014. Smart Energy in Everyday Life: Are You Designing for Resource Man? *Interactions* 21, 4 (July 2014), 24–31. <https://doi.org/10.1145/2621931>
- [81] Kim-Pong Tam. 2013. Concepts and measures related to connection to nature: Similarities and differences. *Journal of Environmental Psychology* 34 (June 2013), 64–78. <https://doi.org/10.1016/j.jenvp.2013.01.004>
- [82] Kim-Pong Tam. 2013. Dispositional empathy with nature. *Journal of Environmental Psychology* 35 (Sept. 2013), 92–104. <https://doi.org/10.1016/j.jenvp.2013.05.004>
- [83] Suzanne C. Gagnon Thompson and Michelle A. Barton. 1994. Ecocentric and anthropocentric attitudes toward the environment. *Journal of Environmental Psychology* 14, 2 (June 1994), 149–157. [https://doi.org/10.1016/S0272-4944\(05\)80168-9](https://doi.org/10.1016/S0272-4944(05)80168-9)
- [84] Edward O. Wilson. 1986. *Biophilia*. Harvard University Press, Cambridge, MA, USA. <https://doi.org/10.4159/9780674045231>
- [85] Matthew J. Zylstra, Andrew T. Knight, Karen J. Esler, and Lesley L.L. Le Grange. 2014. Connectedness as a Core Conservation Concern: An Interdisciplinary Review of Theory and a Call for Practice. *Springer Science Reviews* 2, 1 (Dec. 2014), 119–143. <https://doi.org/10.1007/s40362-014-0021-3>